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ABSTRACT

Although numerous research studies have shown that viewing educational television results in significant gains in preschool and school-age children's academic knowledge or skills, there is less consistent evidence regarding transfer of learning, the application of knowledge or skills learned in one context to a new problem or situation. This paper is a first attempt to provide a theoretical basis for transfer from educational television and to describe factors that can be built into educational television programs to maximize the possibility of transfer. The paper takes several factors that are common across many existing theories of transfer and applies them to the context of educational television. In addition, the paper draws upon the literature on children's learning from educational television and on the capacity model, which describes some of the processing underlying comprehension of educational content on television. Three factors viewed as critical to transfer of learning are examined: (1) the viewer's initial learning or comprehension; (2) the nature of the viewer's mental representation of the content; and (3) the transfer situation, the novel problem to which the content is subsequently applied. The paper concludes by asserting that the likelihood with which transfer will occur is a function of the characteristics of the viewer (such as developmental differences in metacognition and ability to draw inferences), the program (such as the distance between the narrative and educational content), and the transfer situation (including the relationship between the narrative and the underlying educational context). It is noted that although many unanswered questions remain, this paper provides a starting point for discussion and research. (Contains 55 references.) (KB)

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Transfer of learning from educational television:

When and why does it occur?

Shalom M. Fisch

Sesame Workshop

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Numerous studies have shown viewing of educational television to result in significant gains in preschool and school-age children's academic knowledge or skills (see Fisch, in press for a review). However, the evidence is less consistent regarding transfer of learning. Transfer of learning or learning transfer refers to the application of knowledge or skills learned in one context (in this case, a story in an educational television program) to a new problem or situation that differs from the one that was encountered previously.

Consider, for example, the following findings from a summative evaluation of the impact of Cro, an educational television series focused on science and technology (Goodman, Rylander, & Ross, 1993; cf. Fisch, Goodman, McCann, Rylander, & Ross, 1995): After watching an episode of Cro about airplanes and flight, viewers of Cro showed significantly greater comprehension of the educational content in the episode than children who had not viewed the episode. When shown pictures of failed attempts at flying machines that were taken from the episode, significantly more Cro viewers than nonviewers explained the failures in terms of underlying principles (i.e., the size, shape, and sturdiness of the wings), rather than surface features (e.g., saying that the devices didn't look like airplanes). Yet, when the children were presented with an analogous new problem in which they were asked to make similar judgements about a set of new model airplanes, viewers did not differ significantly from nonviewers.

Similarly, an early summative study of the mathematics series Square One TV assessed comprehension of the mathematical content in several mathematical problem-solving segment on three levels: recall of the problem and solution shown, understanding of the underlying mathematical content, and extension (i.e., transfer) to new problems (Peel, Esty, Rockwell, & Gonzer, 1987). Although comprehension varied somewhat across the ten segments used in the

study, a general trend emerged, with the greatest performance found on the level of recall, followed by understanding, which was followed in turn by extension. Thus, while some children were able to solve the extension problems, others showed evidence of understanding the mathematical content without transferring it to new problems. A comparable transfer failure was reported by Hodapp (1977), who found that five- and six-year-old children could reproduce the problem-solving strategies modeled in a segment from Sesame Street to solve a similar problem but not apply the same strategy to a new problem -- even though other studies have found long-term effects of exposure to Sesame Street that endure between one and ten years (D. Anderson, Huston, Wright, & Collins, 1998; Wright, Huston, Scantlin, & Kotler, 2001; Zill, 2001; cf. Huston, D. Anderson, Wright, Linebarger, & Schmitt, 2001; Wright & Huston, 1995; Zill, Davies, & Daly, 2001).

Several explanations could be offered for these patterns of results. One approach might grow out of developmental differences; perhaps the thinking of the children in these studies was simply too literal and concrete to allow them to abstract the knowledge gained from the programs to novel problems. A second could concern the limitations of television as a medium; perhaps the two-dimensional, presentational format of television does not encourage transfer in the same way that hands-on experience might. Indeed, in comparing learning from two-dimensional paper diagrams to hands-on experience, Ferguson and Hegarty (1995) found that the two treatments produced equal improvement on a learning task, but that the hands-on learners were better able to solve application problems; they attributed this difference, in part, to the fact that children in the hands-on condition could interact with the materials while those in the diagram condition could not. A third explanation might take a narrower focus on characteristics of the specific televised

material used in the studies; perhaps there were aspects of the programs that inhibited the conditions necessary for transfer, during either the initial acquisition of the information from the television programs or subsequently, while the children were attempting to solve the transfer problems.

Other studies in the literature suggest that, of these three potential explanations, the last approach is the most reasonable. Although no significant transfer was found in the study on Cro, other studies have provided ample evidence of instances of significant learning transfer from educational television. For example, Hall, Esty, and Fisch (1990a; cf. Hall et al., 1990b) found that extended viewing of Square One TV resulted in significant improvements in fifth graders' subsequent performance on mathematical problem-solving tasks that had not been shown in the series. Similar transfer effects from educational television have been found in problem solving among preschoolers (J. Bryant et al., 1999; Mulliken & Bryant, 1999) and science experimentation among school-age children (Rockman Et Al., 1996). Thus, a conception of television as incapable of producing transfer is not supported by the literature. In addition, because some of these studies found significant transfer from preschool television programs, it does not appear that lack of transfer can be explained solely through age differences either. Rather, the most likely scenario is that the occurrence of transfer from educational television is contingent upon several complementary factors: characteristics of the television program, the viewer, and the novel problem that is subsequently encountered in the transfer situation.

In fact, just as transfer effects have emerged inconsistently with regard to educational television, research outside the realm of television has shown learning transfer to be an elusive phenomenon as well. Many studies in the broader fields of education and cognition have failed

to find evidence of transfer -- so many that Detterman (1993) concluded that transfer is probably rare and accounts for little human behavior. Other researchers have been far less pessimistic about the existence of transfer, but nonetheless acknowledge the difficulty inherent in eliciting transfer in experimental settings (e.g., Bransford & Schwartz, 2000; Sternberg & Frensch, 1993).

The inconsistent appearance of transfer in education and cognitive tasks has given rise to a variety of theoretical approaches that attempt to explain the successes and failures of learning transfer in domains such as reasoning, mathematics, problem solving, and vocational training, among others (e.g., Gentner, 1983; Gott, Hall, Pokorny, Dibble, & Glaser, 1993; Holyoak, 1985; Greeno, Moore, & Smith, 1993; Reed, 1993; Salomon & Perkins, 1989). The mechanisms proposed in these theories run the gamut from schema-based cognitive theories to approaches grounded in pragmatic knowledge to theories that treat knowledge as situated so that they focus on characteristics of situations rather than mental representations.

The present paper takes several factors that are common across many of the existing theories of transfer and applies them to the context of educational television. In addition, it draws upon the literature on children's learning from educational television and, in particular, my own capacity model (Fisch, 2000), which attempts to describe some of the processing that underlies comprehension of educational content on television. (The basic structure of the model is described below.) By synthesizing elements of these disparate literatures, this paper represents a first attempt to provide a theoretical basis for transfer from educational television, and to describe factors that can be built into educational television programs to maximize the possibility of transfer.

Before proceeding to the theoretical discussion, it will be helpful to define our terms.

Prior researchers have drawn numerous distinctions among different types of transfer: near versus far transfer, forward versus backward, high-road versus low-road, direct application versus preparation for future learning, and so on. Indeed, Haskell (2001) distinguishes among as many as fourteen different classes of transfer. The focus of this paper is on the type of transfer that has been investigated most often in studies of educational television. This sort of transfer can be considered to fall into the categories of direct application (Bransford & Schwartz, 1999) and high-road transfer (Salomon & Perkins, 1989), although the transfer might be conceived as either near or far and either forward or backward. In other words, the transfer discussed below entails direct application of knowledge acquired from a television program to a new problem or situation, through a process involving mindful abstraction of the material beyond the context shown in the television program. However, the novel problem may be either similar or dissimilar to the one seen on television, and the bulk of the cognitive "work" regarding transfer may take place either during viewing or when trying to solve the subsequent problem.

Theoretical Approach

Stated simply, the finding that significant comprehension of educational television can occur in the absence of transfer can be explained by the fact that transfer requires more than just comprehension of educational content. When all of the necessary prerequisites are met, transfer is likely to occur. Conversely, transfer can be prevented by a failure in any of these areas.

This paper focuses on three pieces of the puzzle that have been seen as critical to transfer of learning (see, e.g., recent reviews by Bransford, Brown, & Cocking [1999] and Haskell [2001]), as applied to the context of educational television:

- The viewer's initial learning or comprehension of the educational content in a television program;
- The nature of the viewer's mental representation of that content; and
- The transfer situation -- that is, the novel problem or solution to which the content is subsequently applied.

Each of these will be considered in turn.

Initial learning/Comprehension

In some ways, the most obvious prerequisite for transfer from educational television is sufficient comprehension or learning of the material being transferred. After all, if viewers have not fully understood the material presented in the program, they can hardly be expected to apply it in other contexts. As Singley and J. Anderson (1989) have noted, failures to transfer are often simply failures to learn the material in the first place.

Numerous researchers have pointed to the importance of a firm knowledge base as a prerequisite for transfer, with particular attention paid to "local knowledge" about the subject at hand (e.g., Bassok & Holyoak, 1993; Bereiter, 1995; Bransford & Schwartz, 1999; Ceci & Ruiz, 1993, Gott et al., 1993; Haskell, 2001; Perkins & Salomon, 1994). Bransford et al. (1999) note that this knowledge base must include an elaborated understanding of the material learned, rather than simply rote memorization (e.g., understanding the reasoning that underlies a mathematical formula, not just knowing the formula itself).

Drawing from a wide body of empirical research, the capacity model specifies a number of factors that contribute to children's comprehension of educational television (Fisch, 2000). Briefly stated, the model proposes that comprehension of educational content on television

depends, not only on the cognitive demands of processing the content itself, but also on the demands presented by the narrative in which it is embedded. In addition, the model argues that comprehension is affected by distance, that is, the degree to which the educational content is integral or tangential to the narrative (Fig. 1). If distance is large, the mental resources needed for comprehension generally are devoted primarily to the narrative; less resources are available for processing the educational content. However, if the educational content is integral to the narrative, then the two complement, rather than compete with, each other; the same processing that permits comprehension of the narrative simultaneously contributes to comprehension of the educational content.

Fig. 1 about here

The capacity model posits three conditions under which children's comprehension of the educational content in a television program would be likely to be strengthened: (1) when the processing demands of the narrative are relatively small (e.g., because few inferences are needed to understand the story or the viewer's language skills are sufficiently sophisticated to follow the narrative easily; see Fig. 1 and Fisch [2000] for a full list of contributing factors), (2) when the processing demands of the educational content are small (e.g., because it is presented clearly or the viewer has some knowledge of the subject already; see Fig. 1 and Fisch [2000]), or (3) when distance is small.

Since comprehension can be seen a prerequisite for transfer, each of these conditions would also be expected to promote transfer by enhancing comprehension. However, the latter

point about distance poses particular issues for transfer, as discussed below.

Mental representation

Researchers such as Hoijer (1990) have suggested that viewers' comprehension of educational content on television involves their using some sort of mental representation to make sense of that content. If the content is thoroughly unfamiliar, then one might imagine that a new representation would be formed. If, as is probably more often the case, the content bears some relation to material already stored in memory, then viewers would be more likely to retrieve an existing representation from memory and use it to make sense of the new information from the television program. In Piagetian terms, the content on the program would be assimilated into that pre-existing mental representation (and interpreted in a manner consistent with the representation), or the mental representation itself would be modified to accommodate the information acquired from the program.

With few exceptions (e.g., Greeno et al., 1993), most theories of transfer assign a central role to the learner's mental representation of the material learned (e.g., Gentner, 1983; Gick & Holyoak, 1983; Salomon & Perkins, 1989; Singley & J. Anderson, 1989). For learned material to lend itself to transfer, the learner must create a mental representation that is abstracted beyond the initial context in which the material was encountered, so that it can be applied in other situations. Some have seen this abstraction as a conscious process, as in Salomon and Perkins' (1989) discussion of "mindful abstraction" or Haskell's (2001) discussion of "reflective practice." Although concrete examples can be helpful in promoting initial comprehension of educational content, overly contextualized content can actually impede transfer if the content is too closely tied to its original context (e.g., Bransford & Schwartz, 1999; Eich, 1985; Gott et al., 1993).

From the standpoint of the capacity model, the notion that transfer requires both strong comprehension and a mental representation that is not overly contextualized might appear to produce an inherent contradiction. The model posits that one of the key characteristics that can promote comprehension is a small distance between narrative and educational content, which occurs when the educational content is highly contextualized in the narrative presented in the program. From the standpoint of theoretical models of transfer, however, deep contextualization could actually impede, rather than enhance, transfer.

How, then, can this seeming contradiction be resolved? The answer may lie in presenting the same educational concept more than once. For television, the optimal solution may lie in keeping distance small, but also addressing the same educational content multiple times in different contexts (as in television series such as Sesame Street, where the letter C might be presented in the context of several different words, such as cow, car, and cookie in the space of a single episode). Such exposure could help children generalize the content beyond the individual contexts presented and see it as applicable in a broad range of situations. (However, it is worth noting the caveat that, as Rosemarie Truglio and I have argued, viewers need to recognize the link among these multiple presentations for such a strategy to be effective [Fisch & Truglio, 2001]).

In fact, this proposal is supported by theory and research outside the realm of television, which has suggested that transfer is promoted by the use of varied practice (e.g., Gick & Holyoak, 1983; Salomon & Perkins, 1989; Singley & J. Anderson, 1989) -- that is, the use of multiple examples and/or repeated practice set in a variety of different contexts. Through this sort of experience, the mental representation of the underlying content is forced to adapt in subtle

ways to each new context, yielding a representation that gradually becomes more detached from the specific contexts presented, so that it can be applied more easily in new situations as they are encountered. Indeed, Butterworth, Slocum, and Nelson (1993) have gone so far as to argue that presenting only one example provides no basis for generalization and transfer.

Adopting this approach can help us to understand the successes and failures of transfer discussed at the beginning of this paper. Series such as Sesame Street and Square One TV, which have been successful in eliciting transfer, have employed magazine formats in which a single episode is made up of a number of short segments. This format provides ample opportunities for reinforcement and varied treatment of the same educational content in multiple narrative contexts. For example, in Square One TV, the use of probability was modeled in a variety of segments and contexts, such as a segment in which a character figures out what makes a rigged carnival game unfair, a music video in which a character has to select the right key to escape a haunted house, and a game show in which strategic play requires considering the probability of different numbers coming up on a spinner. Each of these segments employed a small distance between narrative and educational content, but the cumulative effect of exposure to all of these segments may have contributed to a more abstract, decontextualized representation of probability. By contrast, while the Cro episode on flight also employed a small distance between narrative and educational content, the content was presented in the context of only one story. As a result, it was successful in producing effects on comprehension, but the underlying mental representation may have been less likely to be abstracted beyond the specific context shown in the program.

The transfer situation

To this point, this discussion has dealt primarily with the "front end" of the process of transfer, focusing on children's initial comprehension of an educational television program and their mental representations of its content. However, to fully understand transfer, we also must understand the processing that takes place later, when children encounter a problem to which the content might be applied (referred to in the literature as the transfer situation) -- that is, the processing that allows them to retrieve the appropriate information from memory and apply it to the problem at hand.

Transfer effects do not occur in a vacuum, and the material learned from an educational television program is not the only information that is stored in children's memory as they approach a potential transfer situation. Rather, children come to such situations with a repertoire of strategies and information that may be more or less applicable to the particular situation at hand (e.g., J. Anderson, 1983; Siegler, 1989). The probability with which the content acquired from a television program will be applied is a function of the associative strength of that content relative to all of the other competing material that is stored in memory. This principle is akin to the effects of mental set in problem solving (e.g.. Luchins, 1942) and Duncker's (1945) classic experiment on functional fixedness, in which subjects' preconceptions of the functions of familiar objects prevented them from using the objects in novel ways to solve a problem. As Hall et al. (1990b) postulated in explaining effects of Square One TV on children's use of problem-solving heuristics to solve mathematical problems, such effects can be due either to children's adding new problem-solving heuristics to their repertoire, to their coming to see the heuristics that already exist in their repertoires as more applicable to a broad range of mathematical problems

(the point most relevant to our discussion here), or to increased motivation during problem solving.

From this perspective, to find significant effects of transfer from educational television, it is not sufficient for the material to have been comprehended and for an appropriate mental representation to have been stored in memory. The child must also see the educational content of the program as applicable to the present situation (e.g., Bassok & Holyoak, 1993; Salomon & Perkins, 1989) and select it from among all of the other material stored in memory as the one that will be applied. Indeed, if a child holds a particularly strong misconception related to the transfer situation (e.g., a naive theory about a scientific principle that is actually invalid), the child could wind up applying a strategy that is not only different than the one presented in the educational television program, but completely incorrect (e.g., Butterworth et al., 1993; Haskell, 2001).

How do children choose among all of the material in their repertoire to select the particular approach that will be used in the transfer situation? As in the case of initial learning of the material, most theorists posit that children create a mental representation of the problem presented in the transfer situation. Beginning with Thorndike's (1913; Thorndike & Woodworth, 1901) work a century ago, a lengthy tradition suggests that the mental representation of the problem is compared to the existing representation of the material learned earlier (in this case, in a television program), to evaluate the degree to which they share similar elements; if they are seen as sufficiently similar, then the previously-learned material is applied and transfer occurs (e.g., Singley & J. Anderson, 1989). However, the similarity must not only exist but also be recognized by the child; if the similarities are not noticed, then the appropriate material is less likely to be applied (e.g., Ceci & Ruiz, 1993).

This state of affairs is complicated by the fact that there is more than one way in which the representations might be similar, and the type of similarity to which the child attends can hold implications for the likelihood of transfer. Several researchers have drawn a distinction between surface structure similarity and deep structure similarity (e.g., Holyoak & Koh, 1987; Medin & Ortony, 1989; Novick, 1988), a distinction that is consonant with the capacity model's differentiation between narrative and educational content. Surface structure similarity refers to similarity between the content of the story contexts in the initial learning situation and the transfer situation (e.g., whether they both concern baseball), while deep structure similarity reflects common underlying principles (i.e., whether they are isomorphic problems). (Cf. Bassok & Holyoak's [1993] similar distinction between pragmatically relevant and irrelevant aspects of problems and Reed's [1993] distinction among equivalent, similar, and isomorphic problems).

Just as the capacity model predicts that, under some conditions, television viewers will comprehend the narrative content of a program without understanding its underlying educational content, researchers in the area of transfer have noted that learners may attend to surface structure similarity rather than deep structure similarity when searching memory for material to be applied in a transfer situation. Often, this type of search, too, may aid performance, since surface and deep structure are typically correlated (that is, in the terms used in the capacity model, the distance is typically small). However, when the two do not go hand-in-hand (i.e., what the capacity model refers to as a large distance), a reliance on surface structure similarity can actually impair performance via negative transfer of inappropriate strategies that only seem appropriate to the learner because of the contexts in which they were embedded (e.g., Bassok & Holyoak, 1993; Holyoak & Koh, 1987; Medin & Ortony, 1989; Novick, 1988; Reed, 1993).

Thus, an abstract mental representation of the transfer situation is as necessary for effective transfer as an abstract representation of the initial content learned.

Developmental considerations

As noted earlier, transfer of learning from educational television has been found to occur in children as young as preschoolers (J. Bryant et al., 1999; Mulliken & Bryant, 1999; cf. research on the long-term effects of Sesame Street, which probably reflects a somewhat different type of transfer). However, while transfer from educational television does occur among young children, several aspects of development can contribute to make transfer more likely to occur as children grow older.

In comparing comprehension of metaphor among four- and five-year-olds, nine- and ten-year-olds, and adults, Gentner (1988) found significant age differences in the degree to which subjects appreciated metaphors on the level of their underlying relational structure, rather than shared surface attributes. Thus, one would expect it to be easier for children to attend to deep structure similarities as they grow older, resulting in a greater tendency toward transfer.

Interestingly, Brown, Kane, and Long (1989) have proposed that such differences stem less from limitations on young children's thinking than from the smaller knowledge base that they have available to apply to transfer situations. Within the context of analogical reasoning, these researchers found children's performance to be greater when they possessed the relevant knowledge base necessary for understanding the relations used in their analogies. Similarly, in comparing adult experts to novices, researchers such as Novick (1988) have found that novices are more likely to attend to surface structure similarities, while experts are more likely to attend to deep structure similarities. Since knowledge increases naturally with age, one would expect

children to attend more easily to deep structure similarities and demonstrate transfer as they grow older.

A similar, but less broad, factor concerns age differences in children's comprehension of television. In the absence of ceiling effects, numerous studies have found comprehension of television to increase with age (Fisch, 2000; cf. Huston & Wright [1997] for a review that includes many studies demonstrating age differences in comprehension). If, as argued above, comprehension is essential to transfer from educational television, then one would expect the probability of transfer to increase along with comprehension.

Moreover, some age differences in comprehension of television have been shown to stem from older viewers' greater ability to draw inferences about events and characters' motives (e.g., Collins, 1983). This suggests that older viewers are better able to go beyond the information presented on the screen and elaborate it more fully, which could result in more elaborate and abstract mental representations of the content shown. As a result, older viewers might create mental representations that are more abstract, this could be conducive to a greater tendency toward transfer as well.

Finally, age differences may also stem from developmental increases in metacognition. Several theories of transfer have proposed that metacognitive processes such as comprehension monitoring or active monitoring of learning strategies play a critical role in transfer, either in encoding material during initial learning or in guiding the search for relevant stored material while engaged in a transfer situation (e.g., Bransford & Schwartz, 1999; Gick & Holyoak, 1983; Gott et al., 1993; Salomon & Perkins, 1989; Sternberg & Frensch, 1993). Since research has shown that children's facility with metacognitive processes such as comprehension monitoring

increases with age (see, e.g., Baker & Brown, 1984 for a review), this greater metacognitive ability could also contribute to developmental increases in transfer.

Conclusion

This paper opened with the question of why educational television programs sometimes have been found to be successful in promoting transfer and sometimes have not. The various considerations discussed above are by no means a comprehensive list of all of the determining factors in transfer (see reviews by Bransford et al., 1999; Haskell, 2001; Perkins & Salomon, 1995). However, these considerations can help us to understand the pattern of effects regarding transfer that has emerged from literature on the impact of educational television. For significant transfer effects to appear: viewers must comprehend and/or learn the educational content presented in the program; they must create a mental representation of the content that is abstracted beyond the narrative context of the program; they must create a similarly abstract representation of the problem encountered in the transfer situation; they must retrieve the representation of the television program's educational content from memory; they must see the stored content as applicable to the new problem, perhaps by mapping similar elements (particularly deep structure elements) of the two representations onto each other; and they must take action by applying the stored content in the transfer situation. A failure at any of these stages can impede or even prevent transfer from occurring.

The likelihood with which transfer will occur is a function of both viewer and program characteristics, as well as characteristics of the transfer situation. The above section on developmental differences lists some of the characteristics of viewers that can contribute to transfer. To this list, we can add other viewer characteristics that may be less integrally tied to

development, such as viewers' motivation or their orientation toward encoding for transfer (e.g., Bransford et al., 1999; Haskell, 2001; Sternberg & Frensch, 1993), as well as the various viewer characteristics that contribute to viewers' initial comprehension of the educational content in the television program (Fig. 1; Fisch, 2000).

Program characteristics, too, include those characteristics that contribute to initial comprehension of the program (Fig. 1; Fisch, 2000), as well as characteristics that pertain more directly to transfer itself. In particular, issues arise concerning the role of the distance between the narrative and educational content in the program. On the one hand, the distance between narrative and educational content should be kept small to enhance comprehension. On the other hand, if the educational content is tied too closely to the narrative, then it may not lend itself to a sufficiently abstract mental representation to produce transfer. As argued above, then, the optimal solution may be to present the same educational content repeatedly but embedded in different narrative contexts. It is noteworthy that when Peel et al. (1987) presented children with a single Square One TV segment on a given mathematical topic, they found stronger performance on understanding of the mathematical content than on extension to new problems, but that Hall et al. (1990a, 1990b) found significant transfer effects after presenting children with multiple segments (many of which employed similar content in different contexts) from the same television series. Similarly, Hodapp (1977) failed to find transfer effects from a single Sesame Street segment, but several studies have found long-term effects of more prolonged exposure to Sesame Street (D. Anderson et al., 1998; Wright et al., 2001; Zill, 2001; cf. Huston et al., 2001; Wright & Huston, 1995; Zill et al., 2001). And one of the tasks on which J. Bryant et al. (1999) found significant transfer effects from Blue's Clues employed a format that was strikingly similar

to the type of problem presented at the end of every episode of Blue's Clues (i.e., a riddle task that involved guessing an object from three clues/attributes).

Factors inherent in the transfer situation include the relative strength of the approaches that viewers have acquired from sources other than the television program and that compete with the educational content of the program during retrieval. Naturally, this is not to say that the competing approaches are necessarily wrong; they may also be applicable to the problem at hand, but would reflect transfer from something other than the television program. Thus, transfer from an educational television program would be more likely to occur in the absence of either a well-practiced, appropriate but competing strategy (which could also produce a correct response in the transfer situation) or a deeply held naive theory or misconception (which would be more likely to produce an incorrect response).

Consistent with the key role that the capacity model assigns to distance in comprehension, another factor relevant to the transfer situation is the relationship between the surface structure (i.e., narrative) and deep structure (i.e., underlying educational content) at work in the transfer situation. When the surface structure and deep structure do not yield similarity to the same material stored in memory, attention to surface structure over deep structure can result in negative transfer effects and the wrong material being applied.

Of course, all of this is only the tip of the iceberg regarding transfer from educational television. The factors discussed here are not exhaustive, nor does this discussion pertain to all types of transfer that have been considered in the literature on education and cognitive psychology. In particular, Bransford and Schwartz (1999) have recently begun to explore a type of transfer that they term preparation for future learning, in which transfer effects consist, not of

applying previously-learned material directly to a new problem, but of past learning helping learners to ask the right questions and seek appropriate information to help them in approaching a new problem or situation. Such a construct might be helpful in considering effects such as the long-term impact of Sesame Street on academic achievement over a period of years (e.g., D. Anderson et al., 1998; Huston et al., 2001), the impact of Dragon Tales on young children's inclination to pursue challenges (Rust, 2001), or the impact of Cro on children's interest in engaging in science and technology activities (Fay, Teasley, Cheng, Bachman, & Schnakenberg, 1995a; Fay et al., 1995b).

Clearly, many unanswered questions remain. Yet, while this paper does not provide an exhaustive theoretical explanation for transfer, it does provide a first step and a starting point for conversation. Hopefully, it will stimulate others to delve into these issues as well, in the interest of yielding a richer understanding of learning transfer from educational television.

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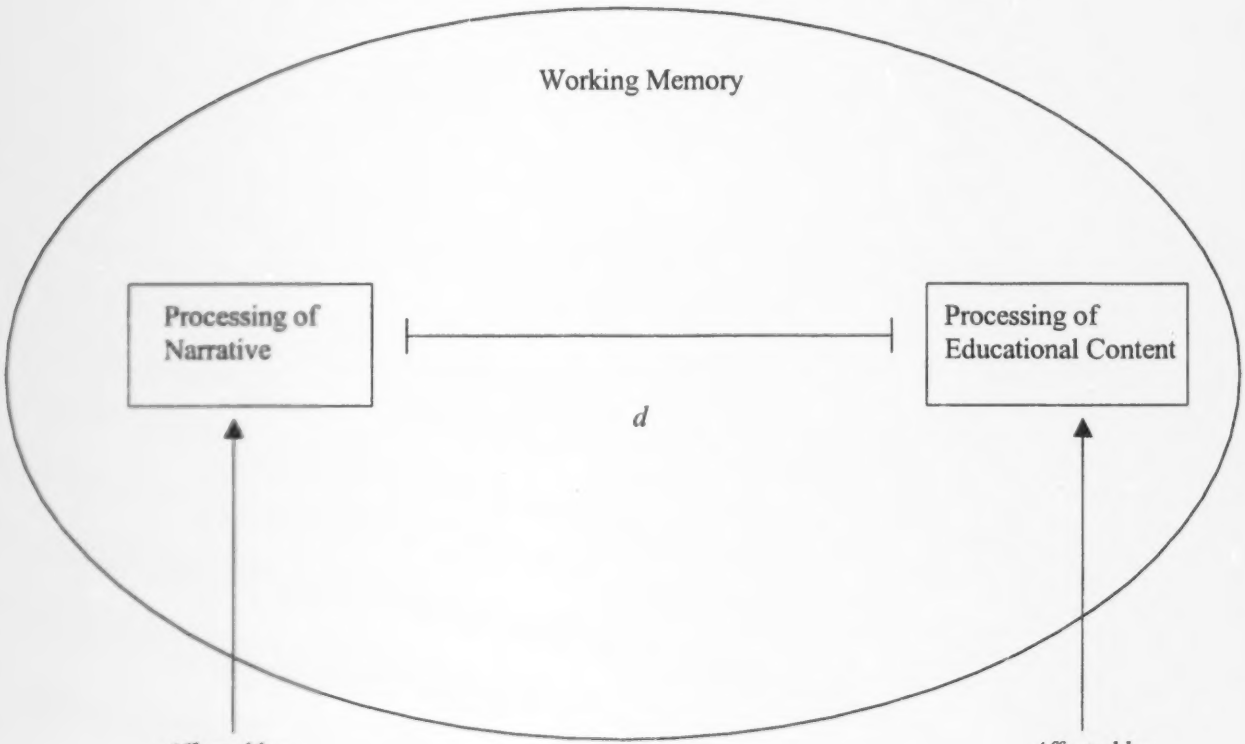
Figure 1. Theoretical construct described by the capacity model, with factors that determine the resource demands for comprehending narrative and educational content (after Fisch, 2000).



Affected by:

Viewer characteristics
Prior knowledge: story/characters
Story schemas
Knowledge/schemas: formal features
Interest in subject matter
Verbal reasoning ability
Short-term memory

Program characteristics
Complexity/coherence of story
Need for inferences
Fit to existing story schemas
Temporal organization
Advance organizers

Affected by:

Viewer characteristics
Prior knowledge of content
Interest in content

Program characteristics
Clarity of presentation
Explicitness of content
Advance organizers